spores which might have been shaken from the feet and proboscides of the flies and have not traversed the digestive canal. From the connection it might naturally be supposed that no attempts were made.

Turning from a determination of the fact experimentally, the author, first making the statement that "it seems very probable that most all of those fungi whose spores are ultimately contained in a slimy or liquid substance of dark color, especially if of a fetid odor, and which is freely accessible, will be found to have their spores largely transported by the agency of insects," takes up the British *Coprini*, pointing out the superficial resemblance of their sporophores to the compound flowers of certain *Compositæ* and calling attention to the fact, in connection, that flies are alike the principal visitors of the flower and the fungus.

The *Phalloidei*, which to the author present the most striking adaptations to insect visitations, occupy considerable space in the paper, short tabulated descriptions—color, odor, habitat, and dimensions—of 59 species being contained. The summary from these descriptive tables shows that the color of the receptacle during the deliquescence of the hymenium in more than half of the species is some tint of red, and in the remainder, white; these colors occurring in 91 per cent. of the 59 species. Table IV gives the colors of more than a thousand species of fungi, other than *Phalloidei*, and reveals the fact that while 91.5 per cent. of the latter are either red or white, only 20.1 per cent. of other fungi are so colored, the great majority being brown, slate, or black—colors scarcely represented in the former group. The bearing of these data upon the author's inference that the brilliant tints of the *Phalloidei* have been developed to render them conspicuous is quite pointed, and when taken in connection with his last table—which is a comparison of 4,197 species of flowers with 59 *Phalloidei* and 1,288 other fungi—becomes doubly so. Table V shows that while only 73 per cent. of flowers and 24.7 per cent. of other fungi are white, red, or yellow—colors found by experiment to be the most conspicuous in wooded localities where fleshy fungi grow—96.6 per cent. of the *Phalloidei* are so colored.

In regard to the odor, determined in the case of 25 species, 76 per cent. were fetid. When this proportion is compared with that of odorous to inodorous flowers—9.9 per cent. determined from 4,189 species—and taken in connection with the numerous facts just mentioned, the author is warranted in concluding that "in the *Phalloidei* it can scarcely be doubted that we have a group of fungi which have undergone great modifications so as to become adapted for the dispersion of their spores by the agency of insects."—D. G. FAIRCHILD.

GIRARD, ALFRED. *Entomogenous Fungi.* Bulletin Scientifique de la France et de la Belgique. January–April, 1889.

This number contains three valuable and practical articles on Entomogenous fungi. The first, entitled (*Sorosporella agrotidis*, nov. gen.

et sp.) "A New Parasite of the Caterpillar of the Sugar Beet," is translated by A. Girard from a German article by N. Sorokin.*

The "gray worm" (Caterpillar of *Agrotis segetum*) is, he says, very troublesome in the southern provinces of Russia, and, judging from previous experiences with the wheat aphis, he thinks it possible to fight the enemy effectually by means of entomogenous fungi; but it is of the greatest importance that each farmer should know beforehand the amount of fungous powder (powder containing the spores of the fungus employed) required to infect a given area. To this end Professor Cienkowski has calculated the number of spores contained in a square millimeter and then in a cubic foot. Professor de la Rue has also estimated how much pure spore powder it requires to cover a given area with a layer of spores .008 of a millimeter thick (twice the thickness of a spore). This calculation is supplemented by Professor Saikewitsch, who has determined that the interstices of a given amount of earth will take up one half its volume in pure spores, so that if impure powder is used twice as much will be required as of the pure.

The author placed several diseased "gray worms" in a box, where they soon died, and on examining them he decided that they were infested by a hitherto undescribed fungus to which he gave the name *Sorosporella agrotidis*. It is with this fungus that he hopes to be able to conquer the *Agrotis*.

The second article is a review of the preceding by the editor and translator, Alfred Girard.

He has compared Sorokin's description with Krassilstschik's description of *Tarichium uvella*, also a parasite of *Agrotis segetum* found in Southern Russia, and considers that the two fungi are probably identical. The name, he says, should be *Sorosporella uvella*, as the *T. uvella* of *Krassilstschik* can not be considered an *Entomophthora*, but is more closely related to the genus *Massospora*, Pk.

Northern France is, he says, as subject to attacks from the "gray worm" as Southern Russia, and the most chimerical remedies have been used to fight the scourge. In France he has often met a parasite of the "gray worm," *Entomophthora megasperma*, Cohn., which was of great aid in stopping the ravages of the *Agrotis* in 1867.

Unfortunately, however, only the *Tarichium* form—that is the resting spores—is to be found either in France or Germany, and all attempts at infection with it have failed. These resting spores may, however, develop and produce conidia in certain culture media. The best one for *Entomophthora calliphoræ* being the excrements of a batrachian.

From an incomplete experiment of Krassilstschik it would seem that under certain conditions *E. megasperma* develops the conidial form on the caterpillars of *Agrotis*, and the author suggests that this result might be regularly obtained by keeping the "gray worms" under glass, just

* Published in the *Centralblatt für Bakteriologie und Parasitenkunde*, 1888, IV. Bd. n. 21, pp. 644–647.

as the parthenogenetic generations of aphides can be indefinitely multiplied by keeping them in a continual summer environment. These suggestions are given to indicate the proper line of experiments to be followed out in fixing upon some plan for exterminating the "gray worm" in countries where it is injurious; and the paper closes with the remark that it is time to start in France an entomological department like the one now in operation in the United States.

The third article is another review by A. Girard, this time of a Russian paper, by Krassilstschik, bearing the Latin title: "*De insectorum morbis qui fungis parasitis efficiuntur.*" Much of the article consists of a critical analysis of Krassilstschik's work, and those parts will be omitted. In this review I shall only touch upon the points which have a bearing on the subject in question, and what follows will mainly consist of very free translations of portions of Girard's paper.

On the practical side of the question Krassilstschik seems to have obtained very remarkable results. Artificial cultures of the conidial form (*Isaria*) of certain *Pyrenomycetes* appear to have been made as easily as those of yeast or *Schizomycetes*. This success is very encouraging, and should impel us to take up new experiments on the *Entomophthoreæ*, which, up to the present, have resisted every attempt to cultivate them in lifeless media. Thaxter's researches have shown that some *Entomophthoreæ* are less exclusive in their choice of a host than was formerly supposed.

If Thaxter's experiments are verified, can not we cultivate *E. grylli* on the caterpillars of *Arctia*, which are so common and easy to raise, and use the spores so produced to infect the *Acrideæ* and arrest their ravages?

The observation of an *Entomophthoreæ* parasite on *Cecidomya destructor*, Say, is of very great interest. *Cecidomya destructor* is one of the most injurious insects, and it would be very important to be able to effectually combat it. Krassilstschik has met this fungus both in the *Tarichium* and conidial state. He has also discovered an *Entomophthora* on the caterpillar of the nocturnal *Agrotis segetum*, which, in the vicinity of Odessa, especially attacks the rye. This is a very interesting fact, he observes, for Cohn has found a *Tarichium* on the same caterpillar without ever having met any conidia. In northern France I have met only the *Tarichium* form of the *Entomophthora* of the *Agrotis*, but a few mummified caterpillars which I placed in a moist chamber at a somewhat elevated temperature became covered with a whitish down analogous to the conidial stage of the *Entomophthoreæ;* unfortunately the observation was interrupted and I was unable to demonstrate the presence of conidia.

The discovery of *Botrytis Bassiana*, Bals. on two new hosts (*Musca domestica* and *Athalia berberidis ?*) made by Kowalevsky in the neighborhood of Odessa deserves special note. We know that Metschnikoff has already observed the white muscardine on *Anisoplia.* Krassilstschik

has found the same parasite upon *Cleonus punctiventris*, Germ. The insects that are so formidable to beet growers of southern Russia may then be effectually combatted by three fungi; the green muscardine (*Isaria destructor*, Metsch.), the red muscardine (*Sorosporella uvella*, Krassil.), and the white muscardine (*Botrytis Bassiana*, Bals.).

Vendhalm and Krassilstschik have also discovered a new species of *Isaria* upon an undetermined *Lixus* (larva and nymph), an *Isaria* that can undoubtedly be utilized in ridding ourselves of the different Curculios that attack the *Carduaceæ*.

But the fungus which Krassilstschik has most thoroughly studied is one which he has met on the eggs of the migratory locust (*Pachytylus migratorius*). This is a conidial form which Krassilstschik believes belongs to the *Isaria* of *Cordyceps ophioglossoïdes*, Ehr. & Tul.; this is also, it seems, the opinion of Professors Cienkowsky and Reinhardt, who have seen his preparations of the fungus.

If the *Isaria* on locust eggs is really *Isaria ophioglossoïdes* we find ourselves in the presence of a very curious fact.

The locust eggs evidently do not supply the fungus with sufficient nutriment for the development of the highest order of reproductive organs—the asci. But how does it happen that in certain localities *Cordyceps ophioglossoïdes* abandons the eggs of the *Acrideæ* to develop further on *Elaphomyces?*

The *Elaphomyces* are subject to invasions of numerous parasites and in particular of the dipterous larvæ of the genus *Helomyza*. Now the *Diptera* of this group are in turn often infested by entomogenous *Sphæriaceæ*. It seems to me very probable that the *Cordyceps* parasitic on *Elaphomyces* lived at first in the *Isaria* stage upon the larvæ of the *Diptera* which infested them, and from there extended their mycelium to *Elaphomyces* itself, where, thanks to more abundant nutriment, they could produce their asci. It is even possible that this might have occurred during the phylogenetic evolution, and that at present *Torrubia ophioglossoïdes* and *capitata* attack *Elaphomyces* directly.

The article concludes with the following direct translation (into French) from Krassilstschik's paper.

Although De Bary is lately inclined to accept Tulasne's view that *Isaria* is only the conidial form of *Cordyceps*, and considers it very probable that *Isaria farinosa* belongs to the cycle of development of *Cordyceps militaris*, it is necessary to observe that the genus *Isaria* comprehends an enormous number of forms; and since the union of this genus with that of *Cordyceps* is probable only for one species, it is useful for the time to retain the genus *Isaria* and to designate each form by a special name.

As to *Botrytis Bassiana*, De Bary as well as Brefeld formerly considered it as the conidial form of a Pyrenomycete (*Melanospora parasitica*); he appears, however, to have given up the idea after numerous cultures and experiments.

The genus *Stilbum* has but a few victims and one representative among muscardine fungi. This one is *Stilbum Buqueti*. Although this fungus is not perfectly well known, and for that reason we can scarcely expect to know whether it passes all its stages on insects, still, according to Buquet, the fungus develops only on dead insects; and, judging from Robin's descriptions and excellent drawings, we must accept his view that *Stilbum* develops while the insect is living, completing its development after the death of the same; in a word, it behaves like a true muscardine.

In regard to *Tarichium* I have already said that this genus ought to follow *Entomophthora*. The diffieulty of making artificial cultures of *Tarichium* and the impossibility of the artificial infection of insects with the spores of this fungus render the study of this group of organisms extremely interesting.

In the fungi noted on our list as accidentally developing on insects and possessing an entomogenous function, is one representative of the genus *Cladosporium*. Although the majority of the species of this genus are known as parasitic on plants, and *Cladosporium* does not exhibit parasitic qualities in the animal kingdom, it is necessary to call attention to the one case of this kind supported by a mycologist as experienced and learned as Professor Salensky, of Kazan. It may seem a little strange at first thought that a parasite as useful as *Cladosporium parasitium*, Sorok., which lives upon *Polyphylla fullo*, can be in a given case understood as only an accidentally saprophytic fungus.

It is useless to speak of *Penicillium* as entomogenous. *Penicillium glaucum*, which, in the opinion of Lohde, may be parasitic on a butterfly, *Bryophila raptricula*, can in no sense be reckoned among the entomogenous fungi; and if *Penicillium glaucum* does develop on dead chrysalides that are really attacked with muscardine it is simply as an after effect and a saprophyte. There is no doubt that the chrysalides of which Lohde speaks were already affected by another parasitic fungus before *Penicillium glaucum* developed.

The yeast fungi have nothing in common with the muscardines, and if formerly it was possible to believe, as Bail did, that the house-fly was killed by a yeast fungus, we know now, after the excellent researches of Brefeld, that the supposed yeast is only an *Entomophthora* in a certain stage of development. * * *

It is still necessary to mention the genus *Metarhizium* of which there are also certain representatives on our list. This new genus was established by Prof. N. Sorokin for the green muscardine, discovered by Metschnikoff upon the larvæ of *Anisoplia austriaca*, and called by him *Entomophthora anisopliæ*. As the characteristics of this fungus do not perfectly agree with those of *Entomophthora*, Professor Sorokin proposed to call it *Metarhizium*. But as Metschnikoff has since given the green muscardine the name of *Isaria destructor*, and as my long observations upon this fungus and a large number of pure cultures have proved to

me that the fungus of the green muscardine approaches in every respect the genus *Isaria*, the name *Metarhizium* became useless, the more so because the other representatives of this genus were imperfectly established. The fungus of the green muscardine has, besides, the typical aspect of an arborescent *Isaria* upon the larvæ of *Cleonus punctiventris* when placed in moist sand. In artificial cultures *Isaria destructor* is known besides under the form *Coremium*.

The ingenious names which Lebert has given to different forms of entomogenous fungi, such as *Verticillium*, *Polistophthora*, *Acanthomyces*, etc., by no means represent new forms but are only synonyms for *Cordyceps* and *Isaria*.

It remains to be seen in how many cases muscardine parasites of insects can develop under artificial conditions. It is said that experiments were made upon twenty-four different species of insects and always gave favorable results. Besides these, there were four other cases of contagion, which, although observed under artificial conditions (not in open air), did not arise from spores sown intentionally.

In these latter cases the parasite developed upon insects inclosed in bottles or boxes. It is interesting to note that in almost every case artificial infections are due to fungi of the genera *Isaria* and *Botrytis;* that is to say, to fungi whose artificial cultures succeed marvelously.

On the contrary, infections with the genera *Cordyceps* and *Entomophthora* are more restricted in number. Up to the present time artificial cultures of these genera have not succeeded at all. For the genus *Cordyceps* we have but one experiment by De Bary and for *Entomophthora* three experiments by Brefeld. No experiments have been attempted with *Stilbum*, but judging from the structure of the fungus, so like that of *Isaria*, it appears probable that artificial cultures and infections will succeed as well with it as with *Isaria*. With *Tarichium* all attempts of contagion have failed completely, and consequently artificial culture is shown to be impossible.

If later researches confirm the cycle of development of *Tarichium uvella*, and if the complete development of other representatives of this genus can be obtained in artificial cultures, it will then be possible to attempt infection with spores artificially produced. As has been indicated, the ordinary spores of *Tarichium* will never produce contagion when placed in contact with the bodies of insects.—EFFIE A. SOUTHWORTH.

HARTIG, Dr. ROBERT. *Lehrbuch der Baumkrankheiten.* Zweite verbesserte und vermehrte Auflage. Mit 137 Text-Abbildungen und einer Tafel in Farbendruck. Berlin. Verlag von Julius Springer, 1889. 8vo, cloth, pp. 291.

The second edition of Dr. Hartig's *Lehrbuch* embodies much interesting information in a convenient form and can not fail to meet with the same favorable reception as the first edition published in 1882.